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(54) **CONSTANT VELOCITY JOINT WITH IMPROVED PROFILE**

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(58) **Field of Search** 464/15, 145, 906

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(57) **ABSTRACT**

A constant velocity ball joint includes an outer race having a plurality of first tracks separated by first lands. Each first land has a first land surface. The joint further includes an inner race having a plurality of second tracks separated by second lands. A cage is disposed between the races. The cage has an outer cage surface facing the outer race, an inner cage surface facing the inner race, and a plurality of circumferentially distributed windows. A plurality of torque-transmitting balls are disposed in the windows, and are engageable with the tracks. At least one of the group consisting of the first land surfaces and the inner cage surface includes ramped portions that are engageable with a respective one of the group consisting of the outer cage surface and the inner race.

1 Claim, 2 Drawing Sheets

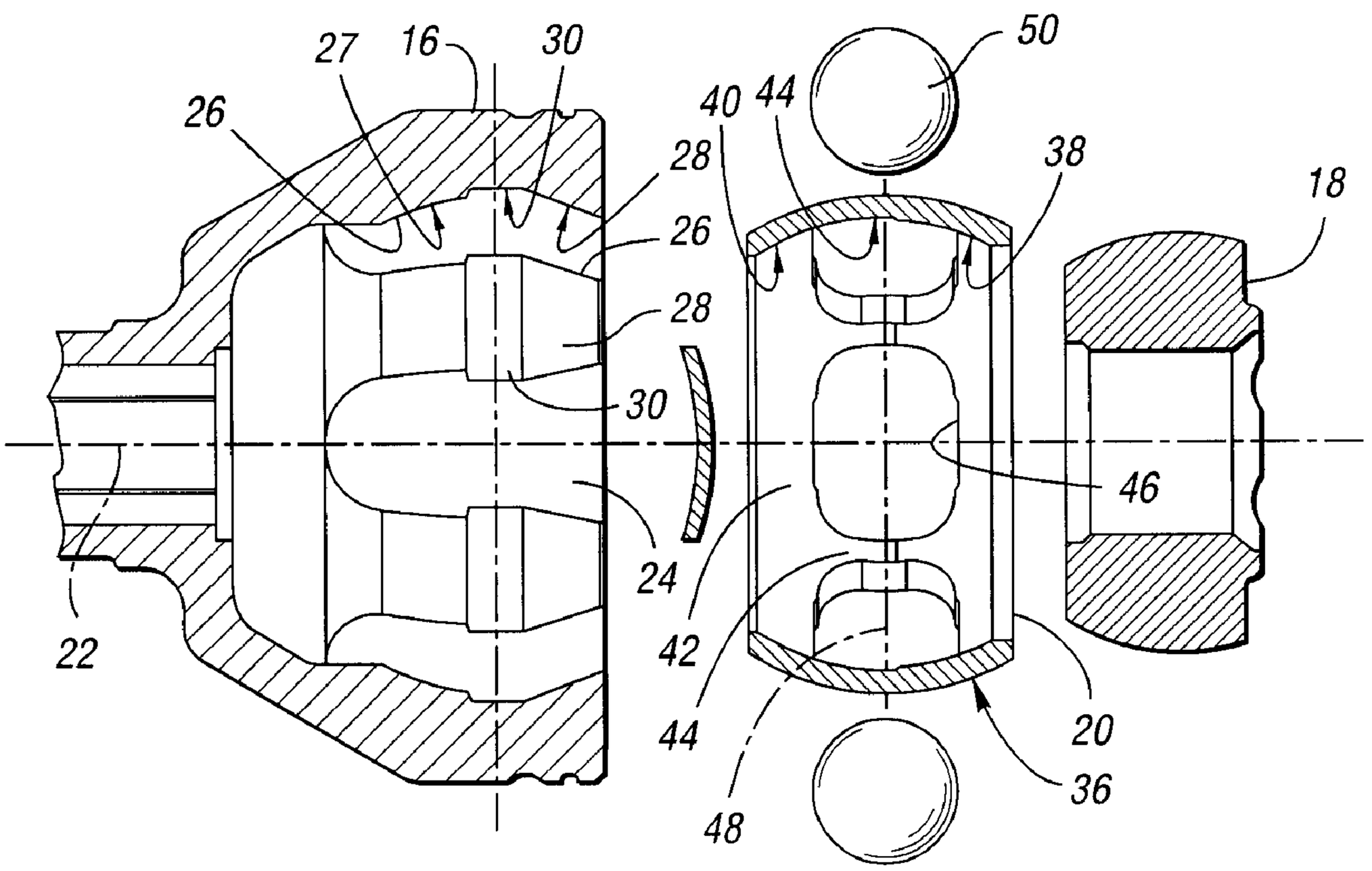


Fig. 1

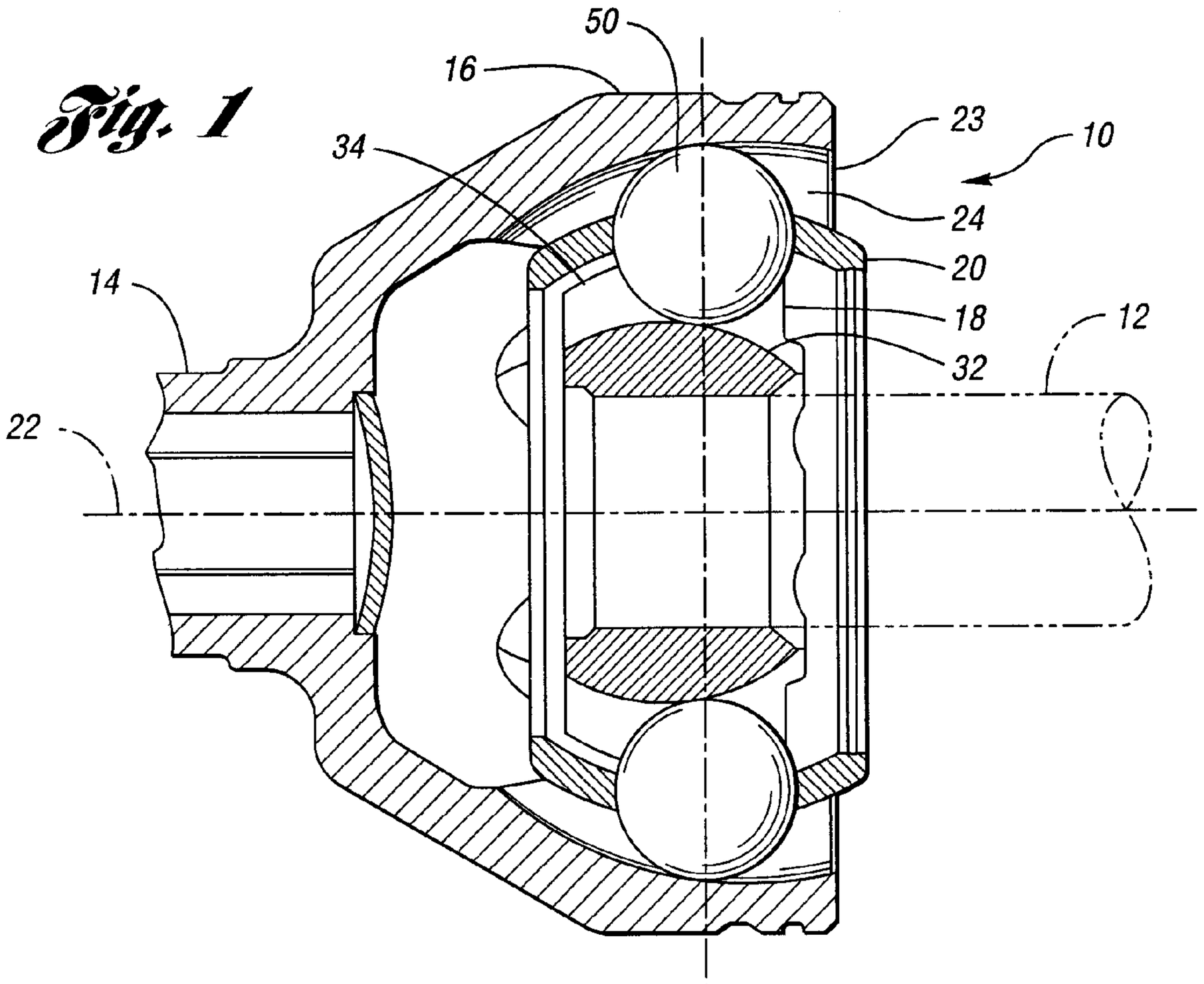
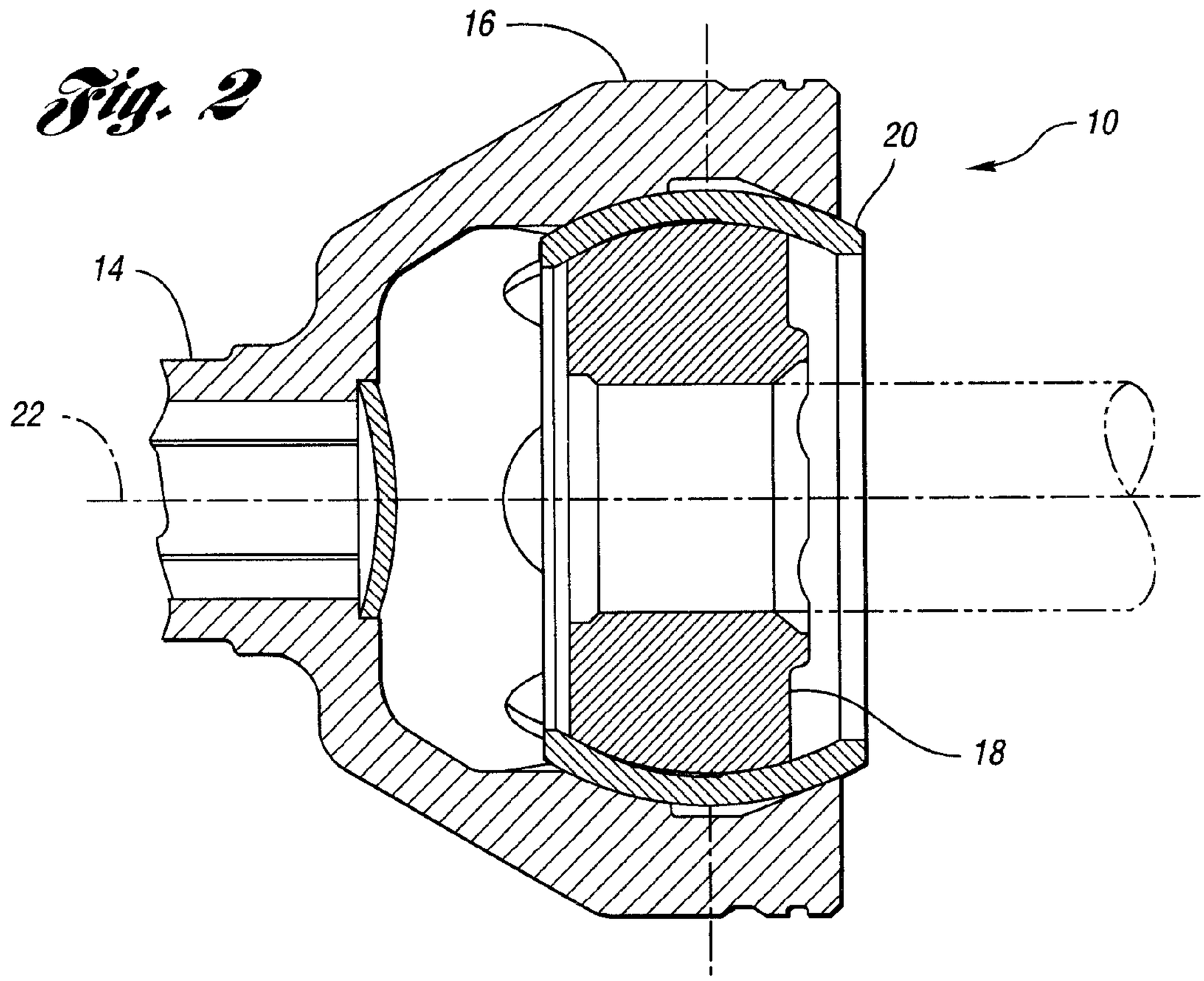


Fig. 2



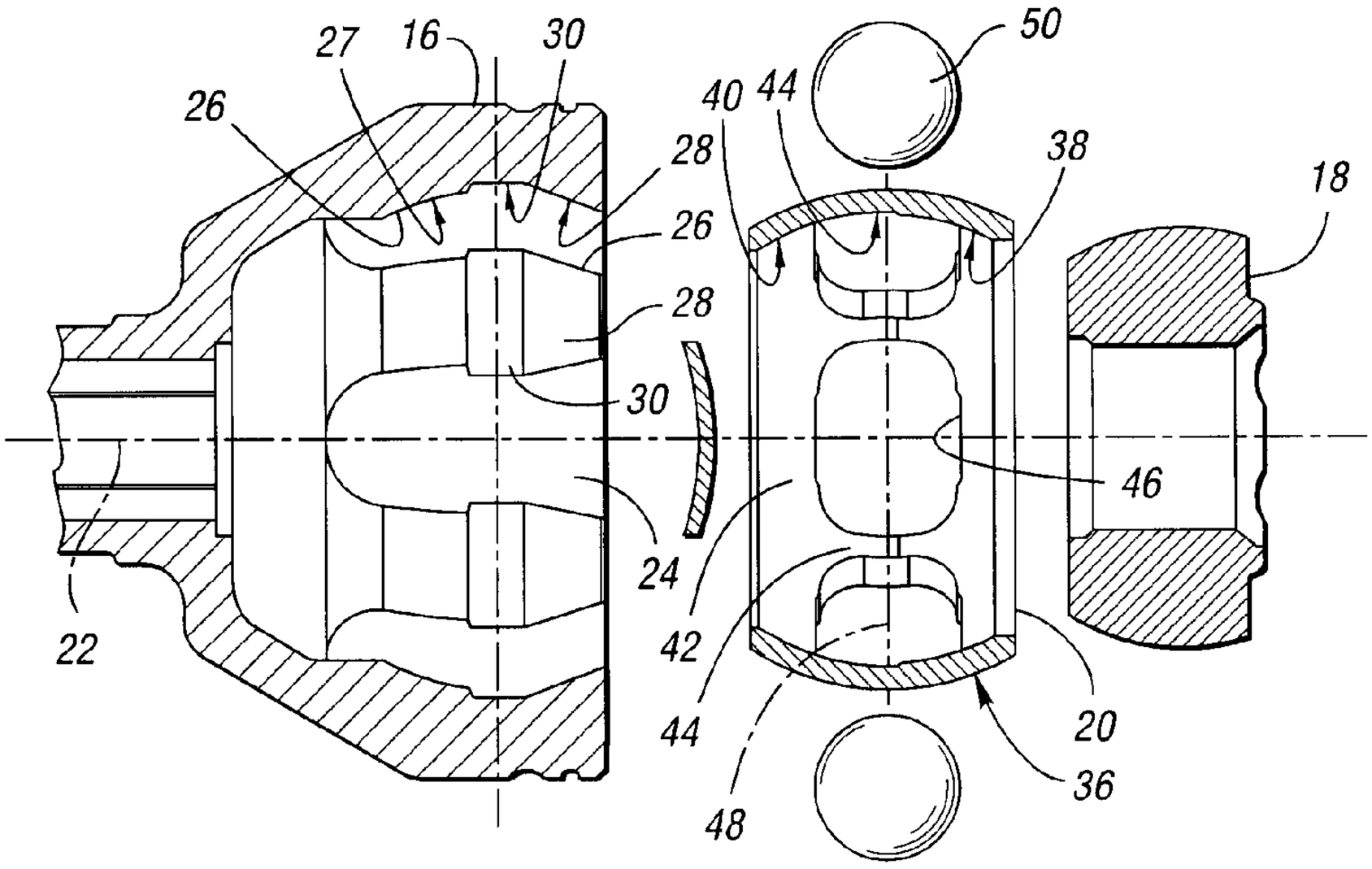


Fig. 3

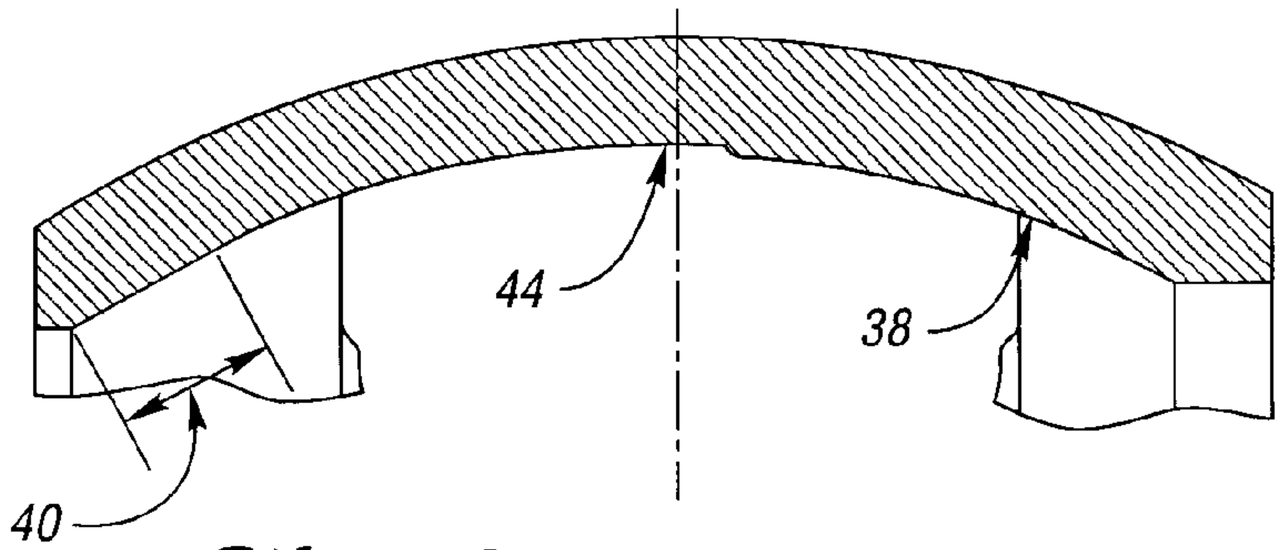


Fig. 4

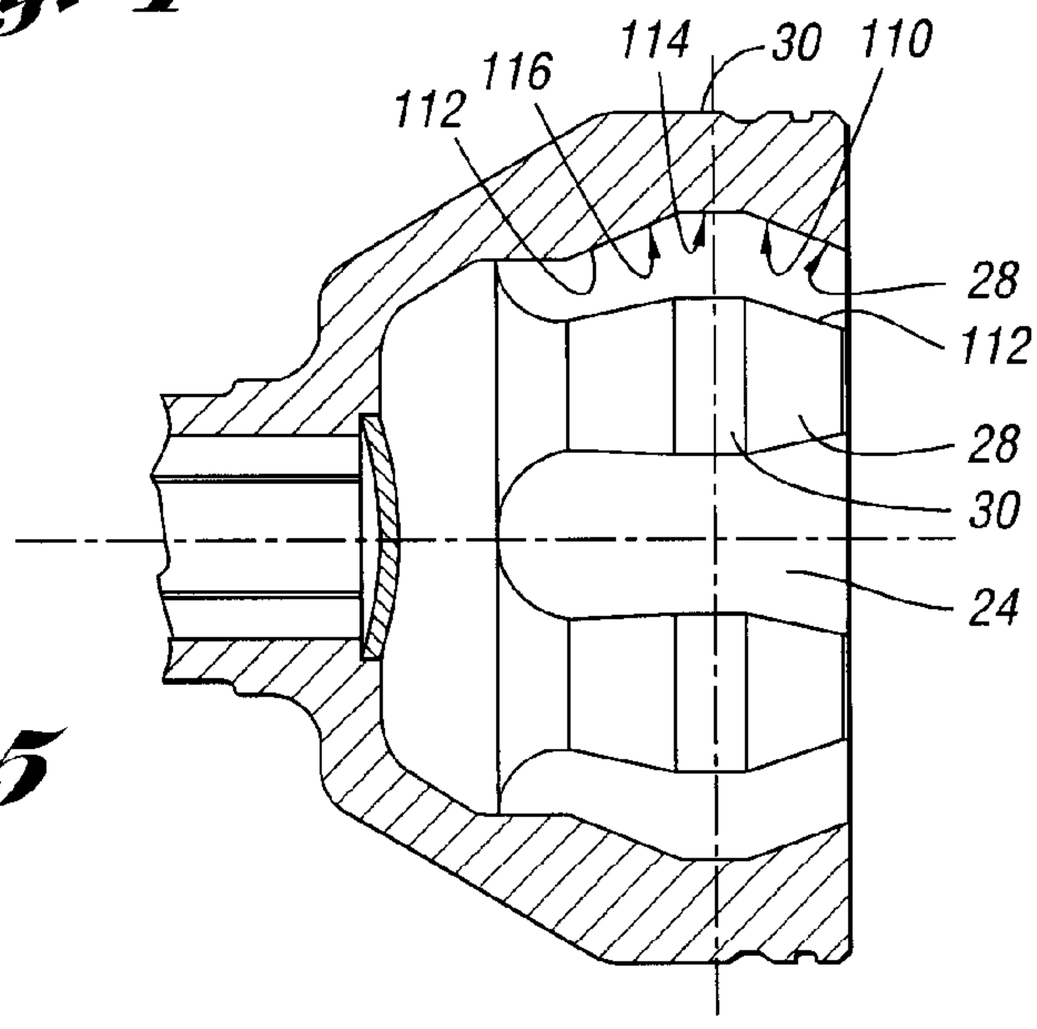


Fig. 5

CONSTANT VELOCITY JOINT WITH IMPROVED PROFILE

TECHNICAL FIELD

The invention relates to constant velocity ball joints that are used to transfer torque between a drive element and a driven element.

BACKGROUND ART

Prior constant velocity ball joints include outer and inner races, and a ball cage disposed between the races. The ball cage typically has a spherical outer cage surface that engages spherical inner surface portions of the outer race, and a spherical inner cage surface that engages spherical outer surface portions of the inner race. With such a configuration, contact between adjacent surfaces is maximized. As a result, frictional losses are significant. Furthermore, it is difficult to lubricate these surfaces.

DISCLOSURE OF INVENTION

The invention addresses the shortcomings of the prior art by providing a constant velocity ball joint having an improved profile that reduces contact between adjacent surfaces. As a result, the joint has improved efficiency and reduced heat generation compared with prior constant velocity ball joints.

Under the invention, a constant velocity ball joint includes an outer race having a plurality of first tracks separated by first lands. Each first land has a first land surface. The joint further includes an inner race having a plurality of second tracks separated by second lands. A cage is disposed between the races. The cage has an outer cage surface facing the outer race, an inner cage surface facing the inner race, and a plurality of circumferentially distributed windows. A plurality of torque-transmitting balls are disposed in the windows, and are engageable with the tracks. At least one of the group consisting of the first land surfaces and the inner cage surface includes ramped portions that are engageable with a respective one of the group consisting of the outer cage surface and the inner race.

The at least one of the group consisting of the first land surfaces and the inner cage surface may further include recessed portions proximate the ramped portions. The recessed portions provide improved lubrication of the joint. Furthermore, the recessed portions cooperate with the ramped portions to provide room for expansion of the cage, which may occur as the joint heats up during operation.

Preferably, the first land surfaces and the inner cage surface each include ramped portions. Furthermore, the ramped portions of the inner cage surface preferably cooperate to define a continuous frusto-conical surface portion.

These and other objects, features and advantages of the invention are readily apparent from the following detailed description of the best modes for carrying out the invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a cross-sectional view of a constant velocity ball joint according to the invention showing an outer race, an inner race and a ball cage disposed between the races;

FIG. **2** is a cross-sectional view of the joint taken at a different angle than FIG. **1** to show engaging surfaces of the races and ball cage;

FIG. **3** is an exploded cross-sectional view of the outer race, ball cage and inner race;

FIG. **4** is an enlarged cross-sectional view of a portion of the ball cage; and

FIG. **5** is a cross-sectional view of a second embodiment of the outer race.

BEST MODES FOR CARRYING OUT THE INVENTION

FIGS. **1** and **2** show a constant velocity ball joint **10** according to the present invention for transferring torque between a drive shaft **12** and a driven shaft **14**. The joint **10** includes an outer joint part or outer race **16**, an inner joint part or inner race **18**, and a ball cage **20** disposed in an annular space between the races **16** and **18**. While the joint **10** is configured to operate through a wide range of angles, FIGS. **1** and **2** show the races **16** and **18** and ball cage **20** aligned along a common central axis **22**.

Referring to FIGS. **1–4**, the outer race **16** is connected to the driven shaft **14** in any suitable manner. Alternatively, the outer race **16** and the driven shaft **14** may be formed as a single component. The outer race **16** includes an open front end **23** and a plurality of first tracks **24** separated by first lands **26**. Each first land **26** includes a first land surface **27** having a first slanted or ramped portion **28** and a first recessed portion **30** disposed adjacent the first ramped portion **28**.

The first ramped portions **28** are load-bearing, conical surface portions that are engageable with the ball cage **20**. More specifically, each first ramped portion **28** curves about the axis **22**, but has a substantially constant slope at any axial cross-section that extends through the particular first ramped portion **28**. In other words, each first ramped portion **28** has a substantially straight line profile.

The inner race **18** is connected to the drive shaft **12** in any suitable manner. Alternatively, the inner race **18** and the drive shaft **12** may be formed as a single component. The inner race **18** includes a plurality of second tracks **32** separated by second lands **34**. The inner race **18** is aligned with the outer race **16** such that each second track **32** is radially aligned with a respective first track **24**.

The ball cage **20** has an outer cage surface **36** facing the outer race **16** and engageable with the ramped portions **28**, and an inner cage surface **38** facing the inner race **18**. The inner cage surface **38** has a plurality of second ramped portions **40**, which are load-bearing, conical surface portions that are engageable with the inner race **18**. Similar to the first ramped portions **28**, each second ramped portion **40** has a substantially constant slope at any axial cross-section that extends through the particular second ramped portion **40**. Furthermore, the second ramped portions **40** preferably cooperate to define a continuous, frusto-conical surface **42**. Additionally, the inner cage surface **38** has a plurality of second recessed portions **44** adjacent the second ramped portions **40**.

The ball cage **20** further has a plurality of circumferentially distributed windows **46** extending from the outer cage surface **36** to the inner cage surface **38**. A cage plane **48** bisects the windows **46**.

A torque-transmitting ball **50** is disposed in each window **46**. Each ball **50** is engageable with a pair of first and second tracks **24** and **32**, respectively, for transmitting torque between the outer and inner races **16** and **18**, respectively.

During operation of the joint **10**, the balls **50** cooperate with the tracks **24** and **32** to urge the ball cage **20** forwardly toward the front end **23** and away from the driven shaft **14**. The balls **50** also cooperate with the tracks **24** and **32** to urge

the inner race **18** rearwardly toward the driven shaft **14** and away from the front end **23**. As a result, the outer cage surface **36** is urged into engagement with the first ramped portions **28**, and the inner race **18** is urged into engagement with the second ramped portions **40**.

Because the ramped portions **28** and **40** have substantially straight line profiles, contact between the outer race **16** and the ball cage **20**, and between the inner race **18** and the ball cage **20** is minimized. Furthermore, with such a configuration, lubrication of the races **16** and **18** and ball cage **20** is significantly improved. As a result, the joint **10** is significantly more efficient than prior constant velocity ball joints. Additionally, heat generated by the joint **10** during operation is significantly reduced.

The recessed portions **30** and **44** enable additional lubricant to be disposed between the outer race **16** and the ball cage **20**, and between the inner race **18** and the ball cage **20**. Furthermore, the recessed portions **30** and **44** cooperate with the ramped portions **28** and **40** to provide room for expansion of the ball cage **20** and/or races **16** and **18**, which may occur as the joint **10** heats up during operation.

FIG. **5** shows a second embodiment I **10** of the outer race. The outer race **110** includes the first tracks **24** of the outer race **16**, and the first tracks **24** are separated by first lands **112**. Each first land **112** includes a first land surface **114**, and the first land surfaces **114** include the first ramped portions **28** and first recessed portions **30** of the outer race **16**. Each first land surface **114** further includes an additional slanted or ramped portion **116** disposed adjacent a respective recessed portion **30**. These additional ramped portions **116** are engageable with the outer cage surface **36** of the ball cage **20**. Thus, the outer race **116** has even less contact with the ball cage **20** than does the outer race **16**. Furthermore, the additional ramped portions **116** provide additional room for the ball cage **20** to expand.

While embodiments of the invention have been illustrated and described, it is not intended that these embodiments illustrate and describe all possible forms of the invention. Rather, the words used in the specification are words of description rather than limitation, and it is understood that various changes may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. A constant velocity ball joint comprising:

an outer race having a plurality of first tracks separated by first lands, each first land including a first land surface having a ramped portion and a first recessed portion adjacent the ramped portion;

an inner race having a plurality of second tracks separated by second lands;

a cage disposed between the races, the cage having an outer cage surface facing the outer race, an inner cage surface facing the inner race, and a plurality of circumferentially distributed windows, the outer cage surface being engageable with the ramped portions of the outer race, the inner cage surface having a frusto-conical portion, and a plurality of second recessed portions adjacent the frusto-conical portion wherein each second recessed portion is at least partially disposed between two windows, and the frusto-conical portion is engageable with the inner race; and

a plurality of torque-transmitting balls engageable with the tracks for transmitting torque between the races, one ball being disposed in each window.

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